# NATURAL RESOURCES CONSERVATION SERVICE
# CONSERVATION PRACTICE STANDARD

# WASTE STORAGE FACILITY
# (No.)

# CODE 313

## DEFINITION

A waste storage impoundment made by constructing a pond (embankment and/or excavated pit or dugout), or by fabricating a structure.

## PURPOSE

To temporarily store wastes such as manure, wastewater, and contaminated runoff as a storage function component of an agricultural waste management system.

## CONDITIONS WHERE PRACTICE APPLIES

- where the storage facility is a component of a planned agricultural waste management system
- where temporary storage is needed for organic wastes generated by agricultural production or processing
- where the storage facility can be constructed, operated and maintained without polluting air or water resources
- where site conditions are suitable for construction of the facility
- to facilities utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads
- to fabricated structures including tanks, stacking facilities, and pond appurtenances.

## CRITERIA

### General Criteria Applying to All Waste Storage Facilities

**Laws and regulations.** Waste storage facilities must be planned, designed, and constructed to meet all federal, state, and local laws and regulations.

**Location.** To minimize the potential for contamination of streams, waste storage facilities should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. Waste storage facilities shall be located so the potential impacts from breach of embankment, structural failure, accidental release, and liner failure are

minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

**Storage period.** The storage period is the maximum length of time anticipated between emptying events. The minimum storage period shall be based on the timing required for environmentally safe waste utilization consistent with the Nutrient Management (590) plan where applicable, and considering the climate, crops, soil, equipment, and local, state, and federal regulations.

**Design storage volume.** The design storage volume equal to the required storage volume, shall consist of the total of the following as appropriate:

(a) Manure, wastewater, and other wastes accumulated during the storage period

(b) Normal precipitation less evaporation on the surface area (at the design storage volume level) of the facility during the storage period

(c) Normal runoff from the facility's drainage area during the storage period

(d) 25-year, 24-hour precipitation on the surface (at the required design storage volume level) of the facility

(e) 25-year, 24-hour runoff from the facility's drainage area

(f) Residual solids after liquids have been removed. A minimum of 6 inches shall be provided for storage facilities that cannot be totally emptied at the end of each storage period.

(g) Additional storage as may be required to meet management goals or regulatory requirements.

**Maximum Operating Level.** The maximum operating level shall be the liquid level that provides for the design storage volume less the volume contribution of precipitation and runoff from the 25-year, 24-hour storm event. The maximum operating level shall be referenced and explained in the O&M plan. On waste storage ponds, a permanent marker or recorder shall be installed at the maximum operating level to indicate where drawdown must begin. A permanent marker or recorder shall also indicate the ½ full level.

**Inlet.** Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage and ultraviolet ray deterioration while incorporating erosion protection as necessary. Inlet components shall meet the requirements of Standard 634, Manure Transfer.

**Emptying Component.** Some type of component shall be provided for emptying storage facilities. It may be a dock, wet well, pumping platform, retaining wall, ramp, gate or pipe. Features to protect against erosion, tampering, and accidental release shall be incorporated as necessary.

Outlet components shall meet the requirements of Standard 634, Manure Transfer. No outlet shall automatically release waste from the required design volume. Manually operated outlets shall be of permanent type designed to resist corrosion and plugging.

**Accumulated solids removal.** Provision shall be made for periodic removal of accumulated solids to preserve storage capacity. The anticipated method for doing this must be considered in planning, particularly in determining the configuration of the facility and the type of liner, if any.

**Safety.** Design shall include appropriate safety features to minimize the hazards of the facility. Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical or flatter unless special traction surfaces are provided. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Warning signs and provisions for ventilation must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines shall be provided with a water-sealed trap and vent, or similar device, if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces. Ponds and uncovered fabricated structures for liquid or slurry waste with walls less than 5 feet above ground surface shall be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose.

**Erosion protection.** Embankments, backfill and disturbed areas surrounding the facility shall be treated to control erosion.

**Environmental Protection.** Waste storage ponds, and waste storage structures that will contain liquid or semi-solid material shall be liquid tight or else include components to isolate, collect, and utilize or treat any contaminated seepage prior to its release to surface or subsurface waters.

**Foundations.** Soils and foundations shall be investigated to a depth at least two feet below the anticipated bottom elevation of the waste storage facility.

In areas of karst or highly fractured bedrock or other highly permeable conditions, the investigation shall extend at least three feet below the anticipated bottom elevation of the waste storage facility, and be performed by a qualified engineer or geologist.

For storage of liquid or semi-solid materials, foundations consisting of bedrock with open joints, fractures, or solution channels shall be grouted or otherwise sealed or a separation layer provided consisting of a minimum of 1 foot of soil with a permeability less than or equal to $1 \times 10^{-4}$ cm/sec between the floor slab or flexible membrane liner and the bedrock or an alternative that will achieve equal protection. A layer of drainfill or geotextile shall be provided to intercept any leakage through the floor slab or flexible membrane liner.

Potential uplift pressures shall be eliminated by drainage or be included in the structural design (including bouyancy and flotation).

Pervious geotextile shall be used to protect drainfill from contamination during the placement of overlying concrete.

Subsurface drainage systems that serve to intercept ground water and/or relieve hydrostatic pressure and/or lower ground water shall be outletted as far from water bodies as possible. Drains should not outlet in surface water bodies whenever possible. If a drain outlets at a water body, it shall be equipped with a sump and/or valve to intercept and redirect contaminated drainage away from the water body. The design of subsurface drainage systems shall address all these items:

1. Locate lines between the expected water source and the storage facility to be protected, but as far as possible from the waste.

2. Drainage lines must have positive and correct slope from beginning to end to convey flow and reduce the risk of blockage from fine soil particles.

3. Drainage lines must have proper depth of cover to reduce the risk of crushing by vehicles and/or construction equipment.

4. Lines must be as short and simple as possible to bring drainage water to a free outlet as quickly as possible. The end of the pipe should be outletted at a short and abrupt elevation change to provide depth of cover as well as provide a proper location to check/monitor the outlet flow. Each outlet shall be marked.

5. Perimeter drains, foundation drains and leak detection systems shall not be inter-connected with other subsurface drains or underground outlets.

6. The area around the outlet should be sufficient to allow effective response, if contaminated discharge should occur from the outlet.

**Slabs on grade.** Slab design shall consider the required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Where applied point loads are minimal and liquid tightness is not required, such as roofed dry stacks, and the subgrade is uniform and dense, the minimum slab thickness shall be 4 inches with a maximum joint spacing of 10 feet. Joint spacing can be increased if steel reinforcing is added based on subgrade drag theory.

For applications where liquid tightness is required such as floor slabs of storage tanks or seepage control liners of waste storage ponds, the minimum thickness for uniform foundations shall be 5 inches and shall contain distributed reinforcing steel. The required area of such reinforcing steel shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, "Design of Slabs-on-Grade".

When liquid tight concrete is required, a construction joint used as a control joint shall contain a waterstop or an elastomeric sealant, which adheres to the concrete on both sides of the joint.

Construction joints that are not used as control joints shall have either a keyway or a ¼ inch thick, six-inch wide steel plate near the center of the slab.

When heavy equipment loads are to be resisted and/or where a non-uniform foundation cannot be avoided, an appropriate design procedure, incorporating a subgrade resistance parameter(s), such as ACI 360 shall be used.

**Additional Criteria for Waste Storage Ponds**

**Soil and foundation.** The pond shall be located in soils with an acceptable permeability that meets all applicable regulation, or the pond shall be lined. Soil liners shall be designed to provide a specific discharge less than or equal to $1 \times 10^{-5}$ cm/sec as described in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

The pond shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless features of special design are incorporated that address

buoyant forces, pond seepage rate and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains, if feasible, to meet this requirement.

**Liners.** Flexible membrane, bentonite, and soil dispersant liners shall meet or exceed the criteria in Standard 521, Pond Sealing or Lining. Liquid tight concrete slabs on grade may also be used for seepage control.

**Embankments.** The minimum elevation of the top of the settled embankment shall be 1 foot above the waste storage pond's design storage volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 1. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

**Table 1 – Minimum Top Widths**

| Total embankment Height, ft. | Top Width, ft. |
|---|---|
| 15 or less | 8 |
| 15.1 – 20 | 10 |
| 20.1 – 25 | 12 |
| 25.1 – 30 | 14 |
| 30.1 – 35 | 15 |

**Excavations.** Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

## Additional Criteria for Fabricated Structures

**Foundation.** The foundations of fabricated waste storage structures shall be proportioned to safely support all superimposed loads without excessive movement or settlement.

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement should be calculated from site-specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 2 or another nationally recognized building code.

**Table 2 - Presumptive Allowable Bearing Stress Values[1]**

| Foundation Description | Allowable Stress |
|---|---|
| Crystalline Bedrock | 12000 psf |
| Sedimentary Rock | 6000 psf |
| Sandy Gravel or Gravel | 5000 psf |
| Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel | 3000 psf |
| Clay, Sandy Clay, Silty Clay, Clayey Silt | 2000 psf |

[1] Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)

In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

**Liquid tightness.** Applications such as tanks, that require liquid tightness shall be designed and constructed in accordance with standard engineering and industry practice appropriate for the construction materials used to achieve this objective.

**Freeboard.** Waste storage structures that will contain liquid or semi-solid material shall be designed with at least six inches of freeboard in addition to the design storage volume.

**Structural loadings.** Waste storage structures shall be designed to withstand all anticipated loads including internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table, and frost or ice pressure and load combinations in compliance with this standard and applicable local building codes.

The lateral earth pressures should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in TR-74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 3 shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the following conditions:

- **Rigid frame or restrained wall.** Use the values shown in Table 3 under the column "Frame tanks," which gives pressures comparable to the at-rest condition.
- **Flexible or yielding wall.** Use the values shown in Table 3 under the column "Free-standing walls," which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

Internal lateral pressure used for design shall be 65 $lb/ft^2$ where the stored waste is not protected from precipitation. A value of 60 $lb/ft^2$ may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used where test fills show that lesser loads can be expected for solid, stackable manure. If heavy equipment will be operated near the wall, an additional two feet of soil surcharge shall be included in the wall analysis.

Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structures Due to Use, and in ASAE EP 393.2, Manure Storages, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon capacity shall be used.

If the facility is to have a roof, snow and wind loads shall be as specified in ASAE EP288.5, Agricultural Building Snow and Wind Loads. ANSI/ASAE "Minimum Design Loads for Buildings and Other Structures" and Midwest Plan Service "Structures and Environment Handbook", MWPS-1 shall be used to determine loading conditions for timber structures.

If the facility is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

**Structural design.** The structural design shall consider all items that will influence the performance of the structure, including loading assumptions, material properties and construction quality. Design

assumptions and construction requirements shall be indicated on standard detail drawings.

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance must be indicated on the construction drawings. The openings in covered tanks shall be designed to accommodate equipment for loading, agitating, and emptying. These openings shall be equipped with grates, fences or secure covers for safety and for odor and vector control.

All structures shall be underlain by free draining material or shall have a footing located below the anticipated frost depth. Fabricated structures shall be designed according to the criteria in the following references as appropriate:

- Steel: "Manual of Steel Construction", American Institute of Steel Construction. Underground steel storage tanks shall have Steel Tank Institute sti-$P_3$ certification.
- Timber: "National Design Specifications for Wood Construction", American Forest and Paper Association, shall be used to analyze timber structures including roof systems and structural connections. All components including trusses, headers, braces, posts and post anchorages shall be included in the analysis.

**TABLE 3 - LATERAL EARTH PRESSURE VALUES[1]**

| Soil | | Equivalent fluid pressure (lb/ft$^2$/ft of depth) | | | |
|---|---|---|---|---|---|
| | | Above seasonal high water table[2] | | Below seasonal high water table[3] | |
| Description[4] | Unified Classification[4] | Free-standing walls | Frame Tanks | Free-standing walls | Frame tanks |
| Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[5] | GP, GW, SP, SW | 30 | 50 | 80 | 90 |
| Gravel, sand, silt and clay mixtures (less than 50% fines) Coarse sands with silt and and/or clay (less than 50% fines) | All gravel sand dual symbol classifications and GM, GC, SC, SM, SC-SM | 35 | 60 | 80 | 100 |
| Low-plasticity silts and clays with some sand and/or gravel (50% or more fines) Fine sands with silt and/or clay (less than 50% fines) | CL, ML, CL-ML SC, SM, SC-SM | 45 | 75 | 90 | 105 |
| Low to medium plasticity silts and clays with little sand and/or gravel (50% or more fines) | CL, ML, CL-ML | 65 | 85 | 95 | 110 |
| High plasticity silts and clays (liquid limit more than 50)[6] | CH, MH | NR[6] | NR[6] | NR[6] | NR[6] |

[1] For lightly compacted soils (85% to 90% maximum standard density.) Includes compaction by use of typical farm equipment.
[2] Also below seasonal high water table if adequate drainage is provided.
[3] Includes hydrostatic pressure.
[4] All definitions and procedures in accordance with ASTM D 2488 and D 653.
[5] Generally, only washed materials are in this category
[6] Not recommended. Requires special design if used.

- Concrete: "Building Code Requirements for Reinforced Concrete, ACI 318", American Concrete Institute.
- Masonry: "Building Code Requirements for Masonry Structures, ACI 530", American Concrete Institute.

**Waste Stacking Facilities.** Stacking facilities for manure with sufficient solids or bedding to be handled as a solid and capable of forming piles or windrows at least four feet high shall be covered with a roof or be provided with a rainfall collection and separation system. A stacking facility shall have a design capacity that assumes the material will have a level top surface at the height of the supporting structural wall, unless a test fill shows that the angle of repose of the material will allow a surcharge of additional stacking and the composition of the material will not become more viscous during the storage period. This sloping surcharge must be included in the design loads of all the structural components.

Stacking facilities shall be designed with adequate safety factors to prevent failure due to internal or external pressures including hydrostatic uplift pressure and imposed surface loads such as equipment that will be used within, on or adjacent to the structure. Lumber shall not be used for walls that support moving stacking elevators or similar loads.

## CONSIDERATIONS

Waste storage facilities should be located as close to the source of waste and polluted runoff as practicable.

Non-polluted runoff should be excluded from the structure to the fullest extent possible except where its storage is advantageous to the operation of the agricultural waste management system.

Solid/liquid separation of runoff or wastewater entering storage facilities should be considered to minimize the frequency of accumulated solids removal and to facilitate pumping and application of the stored waste.

Due consideration should be given to environmental concerns, economics, the overall waste management system plan, and safety and health factors.

**Considerations for minimizing the potential for and impacts of sudden breach of embankment or accidental release from the required volume.**

Features, safeguards, and/or management measures to minimize the risk of failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 4 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in Table 4 may be significantly affected:

1. Additional freeboard
2. Storage for wet year rather than normal year precipitation
3. Reinforced embankment -- such as, additional top width, flattened and/or armored downstream side slopes
4. Secondary containment

**Table 4 - Potential Impact Categories from Breach of Embankment or Accidental Release**

| |
|---|
| 1. Surface water bodies -- perennial streams, lakes, wetlands, and estuaries |
| 2. Critical habitat for threatened and endangered species. |
| 3. Riparian areas |
| 4. Farmstead, or other areas of habitation |
| 5. Off-farm property |
| 6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places. |

The following options should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 4 may be significantly affected. Under all circumstances, the use of gravity outlets is limited by the criteria in Standard 634, Manure Transfer:

1. Outlet gate locks or locked gate housing
2. Secondary containment
3. Alarm system
4. Another means of emptying the required volume

**Considerations for minimizing the potential of waste storage pond liner failure.**

Sites with categories listed in Table 5 should be avoided unless no reasonable alternative exists. Under those circumstances, consideration should be given to providing an additional measure of safety from pond seepage when any of the potential impact categories listed in Table 5 may be significantly affected.

**Table 5 - Potential Impact Categories for Liner Failure**

| |
|---|
| 1. Any underlying aquifer is at a shallow depth and not confined |
| 2. The vadose zone is rock |
| 3. The aquifer is a domestic water supply or ecologically vital water supply |
| 4. The site is located in an area of solutionized bedrock such as limestone or gypsum. |

Should any of the potential impact categories listed in Table 5 be affected, consideration should be given to the following:

1. A clay liner designed in accordance with procedures of AWMFH Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than $1 \times 10^{-6}$ cm/sec
2. A flexible membrane liner over a clay liner
3. A geosynthetic clay liner (GCL) flexible membrane liner
4. A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring liquid tightness

**Considerations for minimizing the impact of odors.**

An anaerobic lagoon instead of a waste storage pond should be considered for sites located in rural areas where odors are a concern. This should be especially considered where odors would affect neighboring farms having enterprises that do not cause odors and/or neighbors who earn a living off-farm. The recommended loading rate for anaerobic lagoons at sites

where odors must be minimized is one-half the values given in AWMFH Figure 10-22.

For sites located near urban areas practices such as the following should be considered to reduce odor emissions:

1. Covering the storage facility with a suitable cover.
2. Using naturally aerated or mechanically aerated lagoons.
3. Using composting in conjunction with a solid waste system rather than a liquid or slurry system.
4. Using a methane digester and capture system.

## PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use. The plans must show all features required for the proper installation and functioning of the practice, including (but not limited to): plan view, cross sections with details (such as reinforcement, waterstops, fasteners, and joint seals), pipes, drainage, erosion and sediment control, access, safety devices, and foundation requirements.

## OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design.

The plan shall contain the operational requirements for emptying the storage facility. This shall include the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan.

In addition, for ponds, the plan shall include an explanation of the permanent marker or recorder installed to indicate the ½ full and maximum operating levels.

The plan shall include a strategy for removal and disposition of waste with least environmental damage during the normal storage period to the extent necessary to insure the facility's safe operation. This strategy is for the removal of the contribution of unusual storm events that may cause the facility to fill to capacity prematurely with subsequent design inflow and usual precipitation prior to the end of the normal storage period.

An emergency action plan is a required component of the operation and maintenance plan for facilities that will contain liquid or semi-solid material, and should be considered for other waste storage facilities where there is a potential for significant impact from accidental release.

The plan shall include site-specific provisions for emergency actions that will minimize impacts on health, safety, and the environment.

The emergency action plan shall be available at the facility at all times. It shall include the phone number(s) for immediately notifying the Department of Environmental Protection of any spill, overtopping, leak or other discharge that would endanger downstream water users or would otherwise result in pollution or create a danger of pollution or would damage downstream property.

In the event the Landowner or Operator has the storage facility emptied by a custom applicator, it is the Landowner or Operator's responsibility to review the

emergency action plan with the applicator prior to agitation or unloading of the storage facility.

When perimeter drains, foundation drains, and leak detection systems outlet closer than 50 feet to a water body, the operation and maintenance plan shall include the requirement for monthly inspection of the outlet. In the event of a suspected problem, the landowner shall take the following actions.

- Intercept the outlet with a sump and pump the water to a location where it cannot adversely effect the quality of the water body and,

- Take immediate action to empty the storage structure and contact the designer of the structure for inspection.

The operation and maintenance plan shall provide information on toxic and explosive gases and safety precautions to be taken, where applicable.

## DOCUMENTATION

A waste storage facility shall not be reported or certified as complete until adequate documentation, showing proper installation, has been prepared. The as-built drawings shall be signed and dated by a person with construction job approval authority to indicate that the facility was installed as designed, except as noted by red line changes.

In addition, the as-built drawings shall include the actual foundation and ground water conditions encountered during construction (if they differ from the site investigation and design assumptions), the name of the installer or manufacturer and the date of completion.

The design folder, as-built drawings, material certifications and specifications shall be filed with the Waste Management System (312) plan.